

**QUARTERLY REPORT**

GTI PROJECT NUMBER 21874

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**Characterization and Fitness for Service  
of Corroded Cast Iron Pipe**

**Contract Number: DTPH56-15-T-00006**

Reporting Period: 5<sup>th</sup> Project Quarter

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## Project Objective

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Gas Technology Institute's (GTI) objective in this project is to

- Provide a Fitness-For-Service (FFS) model and method for operators to characterize and grade graphitic corrosion defects on cast iron natural gas pipes. This will help operators make monitoring, repair, and replacement decisions, as well as prioritize accelerated replacement decisions related to cast iron mains and services.
- Summarize and categorize the required input parameters to the FFS model related to cast iron material, graphitic corrosion geometry and characteristics, and operational environment.
- Validate the FFS model by comparing its output to a statistically analyzed set of historical cast iron failure data.
- Provide a physical testing program to fully validate the FFS model.

## Executive Summary

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During this quarter, we completed Task 3 and 5. Reports were submitted in November summarizing the results from these tasks along with a Task 4 Interim report summarizing the results of the FEA.

## Funds and Work Completed this Quarter (10/1/16 – 12/31/16)

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### *Work Completed*

Task 3. Historical Cast Iron Failures Statistical Analysis –completed

Task 4. Finite Element Analysis of Failure Modes – Completed

Task 5. Characterize Graphitic Corrosion Severity – Completed

## Technical Status

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### *Activity: Task 3 - Historical Cast Iron Failures Statistical Analysis*

Task 3 was completed.

The objective of **Task 3** *Characterization and Fitness for Service of Corroded Cast Iron Pipe* is to provide (1) a review of the cast iron failure incidents, and (2) the associated loads and stresses on cast iron pipes due to external loads and environmental conditions.

A summary report was submitted. The first part of this interim report provides an introduction to the cast iron mains in the natural gas local distribution system and a summary of the associated reported failure incidents.

The second part of this interim report provides a review of the parameters affecting cast iron corrosion and an analysis of the loads and stresses which the cast iron pipes are subjected to in the field.

The task report provides the background and material properties needed for performing the finite element analysis of corroded pipe sections subjected to external loads which is presented in **Task 4** of the project in the interim/milestone reports, *Characterization and Fitness for Service of Corroded Cast Iron Pipe – FEA Design Document and Summary Report of FEA Results*. The calculation of field loads will also be included in the Task 6 interim report, along with examples that are based on this Task 3 report.

Additional details on cast iron and cast iron pipe metallurgy and field corrosion have already been included in the **Task 2** interim/milestone report, *Characterization and Fitness for Service of Corroded Cast Iron Pipe - Cast Iron Materials Literature Search*.

#### ***Activity: Task 4 - Finite Element Analysis of Failure Modes***

Task 4 was completed.

The objective of Task 4 is to model the failure of cast iron piping systems with graphitic corrosion defects. This modeling will be used to determine the critical defect size and characteristics that could lead to premature piping failure. A nonlinear, 3D finite element (FE) model, simulating a single pipe span was utilized. FEA simulations used geometric input parameter combinations as determined by a design-of-experiment (DoE) methodology in order to generate quadratic response surfaces.

Two simulation spaces were evaluated – Simulation Space 1 (SS1) for a pipe segment without a flaw, and Simulation Space 2 (SS2) for a pipe segment with a flaw. Twelve response surfaces were generated from the two simulation spaces, each covering a different combination of flaw geometry and axial restraint condition. The response surfaces are detailed in the body of the report.

The separation of the simulation spaces into several response surfaces necessitates the evaluation of the all response surfaces on a case-by-case basis using a calculator.

#### ***Activity: Task 5 - Characterize Graphitic Corrosion Severity***

Task 5 was completed.

A summary report was submitted. This report is the Task 5 interim/milestone report of the project: Characterization and Fitness for Service of Corroded Cast Iron Pipe and it provides a general set of guidelines an operator will use to characterize the type and severity of graphitic corrosion on a cast iron pipeline in the field.

This will allow the operator to consistently develop part of the input data needed to run the FFS cast iron model which will be delivered under Task 6 of the project, FFS Model for Cast Iron Graphitic Corrosion.

Addition details on cast iron and cast iron pipe metallurgy and field corrosion have already been included in the Task 2 interim/milestone report, Characterization and Fitness for Service of Corroded Cast Iron Pipe - Cast Iron Materials Literature Search.

#### **Plans for Future Activity (Project Quarter #6)**

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The planned activities for the 6<sup>th</sup> Project Quarter are:

- Begin Task 6, 7 and 8.
- Submit monthly and quarterly reports